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POTENTIAL SOIL LOSSES FROM DEFLATION BY NO-TILL-TECHNOLOGIES

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As a result of field research it was determined that the potential soil losses from wind erosion for chernozems southern have been reduced in most cases for several times by No-till technology. The main reason is the substantial increase in ground cover by plant residues in the most dangerous wind erosion period (February-April). It was also noted stabilizing influence of No-till technology on soil dispersion process of the surface layer, which is observed by many cycles "freezing-thawing" for the cold season there was too.

***Key words**: deflation, technology No-till, plant residues, soil dispersion*

Introduction. In the steppe of Ukraine soil deflation (wind erosion) is quite commonplace [1]. Asa result of this process is decrease in soil productivity, which is associated with blowing the top, the most fertile soil layer, and there are such dangerous "side effects" as death as the result of blowing and clampingby soil of agricultural crops, backfilling of drainage channels, deterioration of people's health due to the increase in airborne dust, etc.

The main means of defense with deflation in the steppe zone of Ukraine is the creation resistant to strong winds surface agrolandscapes in deflating-dangerous period (February-April) and the construction of the vertical barriers to windhazardousdirections (for Steppe of Ukraine - North-East and East) in the form of shelterbelts and (or) the scenes.

The stability of agrolandscapes surfaces to deflation in this period is determined by the winter crops and perennial crops in the structure sown area, and the density of plant residues on the soil surface, which is a function of crop type in the previous year and the tillage technology.

It should be noted that in deflating-hazardous areas should be a special approach to the accumulation of plant residues, their grinding and the location on the soil surface (the layer thickness of residues, the degree of coverage of the soil surface, vertical or horizontal orientation relative to prevailing winds, etc.). That is, in the technologies of cultivation agricultural crops should be some separate agricultural practices on the use of plant residues - «*crop residue management*» in English literature [2].

The researchers of modern agricultural crops cultivation technologies are often statethat the high effect of the soil No-till explaining this phenomenon large number of crop residues left on the soil surface (for example, [3]). However, in monographs and articles about No-till, where generalized long-term experience of implementation of this technology, most often comment on agronomic aspects, but soil protectiveeffect of such technology is almost not recognized [2,3].

Attempts of quantitative assessment of No-till soil-protective efficiencythere are only in some papers relating to soils and locations in North and South America. In particular, M.E. Thorne with co-authors [4], making the calculations for agriculture Oregon, showed a significant effect of soil No-till in crop rotation "spring wheat - spring barley", especially after the third rotation (six years), when the mulch covers the soil surface to 100 %.

At the same time, the effect of surface roughness of the soil, which is determined by the method of processing is, according to the authors, an important undeflationfactor manifested in rotation "black couples – winter wheat" until inthe autumn for maximum deflationary dangerous winds in the region in the spring and summer [4]. The effect of No -till, compared with other technologies of cultivation, on soil undeflationproperties been studied in Argentina [5] and stated significant change of soil windproof after years of application of this technology. But the conclusions of this work are not counted the role of plant as a deflation factors, and thus the research results are of limited practical applicability.

The methods and conditions for investigations. To processing techniques for the quantitative determination of soil protection efficiency of the No-till technologyinvestigations were conducted on the chernozem southern of the Askaniya Agricultural Experiment Station territory IIA NAAS (Tavrychanka, Kakhovsky district, Kherson region) within the stationary field experiment for study the effects of different tillage systems and fertilization on crop production.

The researcherswere conducted at four rotation crops - winter wheat (2012, predecessor - peas), sorghum (2012-2013, predecessor - winter wheat), peas (2012-2013, predecessor - sorghum) and springwheat (2013 precursor - peas).

For No-till technology seed drill sowing performed Grain Plains CPH, with inter-rows 19 cm for winter and spring wheat, peas and with inter-rowsspacing 38 cm for sorghum. As a control used traditional for these crops basic soil cultivation –for winter and spring wheat - hard disk harrow disking to a depth of 12-14 cm, in all other cases - deep plowing at 28-30 cm with the rotation soil layer unit chunks PLN -5 -35.

Soil protection criteria selected technologies elected: the mass of vegetation residues; the degree of covering the soil surface (through conditional split 100 squares of the same surface area of a photograph with the following definition of the projective cover in each square);soil lumpy (content of aggregates greater than 1 mm (%) for the dry dispersion soil sample in 0-10 cm layer by the method of N.I.Savvinova.All determinations were performed in three - or fourfold iterations.

Results. As a comprehensive assessment of the soil protection efficiency degree of the No-till technology was used mathematical model regarding the "prediction of dust storms" NSC "Institute of soil science and Agrochemistry named O.N. Sokolovsky" [6], the full version of which is as follows:

$$E_p = \left(0{,}1 \cdot 10^{a-b \cdot K - c \cdot S} \cdot K_S \cdot V_{max}^3 \cdot t \cdot K_P \cdot K_{dc} \cdot K_l \cdot K_{gz}\right) / V_{mod}^3 (1),$$

whereE_p–conditioned potential soil loss, t/haper year;

К –soil lumpy, %; S–number stubble or plant residue on the soil surface, units/m^2;

c, b, a –the coefficients that depend on the genesis, physical and physic-chemical properties of soil and the type and quantity of plant residues [6];

K_s–destruction factor units;

K_p –thecoefficient of relief influence;

K_{dc} –factor "the deflation stability of agricultural crops";

K_l–thecoefficient which indicates the ratio of protection shelterbelts;

K_{gz}–the impact coefficient of soil protection additional measures;

t–multiyear average number of hours with long-term dust storm;

V_{max}–average maximum wind speed during dust storms 20 % probability), m/s;

V_{mod}–the rate of air flow in a wind installation *ПАУ-3*, which is equal to 13.5 m /s (23 m/ s at an altitude wind vane) [6].

The results of calculations by formula (1) is shown in Fig. 1. Apparently, in all cases, the undeflation efficiency of No-till technology is higher than in the controland, when the predecessor of a winter wheat (on crops of sorghum) such absolute efficiency - potential soil loss is about 4 times less than in the control.

The detailed analysis of the components of equation (1) shows that the estimate of soil-protective effect of technology actually consists only of two indexes - the lumpiness of soil and soil-protective efficiency of plant residues (number of stubble and plant residues on the soil surface). The last indicator characterizes the level of soil surface protection from blowing strong winds in the most dangerous the deflation period in February-April. It is obvious that the number of plant residues per 1 m^2 will be proportional to their mass and the square projective cover. Investigations have shown [7] the close relationship (r^2 = 0.89) between projective cover (PP,%), and weightof residues (V, g/m^2), which is approximated by the equation 2:

$$PP=-0{,}15\cdot 10^{-7}\cdot V^{3}+1{,}72\cdot 10^{-4}\cdot V^{2}+8{,}21\cdot 10^{-3}\cdot V \qquad (2)$$

The analysis of the data regarding the effect of the No-till technology on projective covering of the soil surface shows (Fig. 2)that this technology helps protect the soil from wind erosion. The absolute protection of soil during strong winds stated in option experience with the predecessor of a winter wheat, where the projective cover was 100 %.Whenpreceded byother cultures, projective covering of the soil surface at the end of winter and in spring it was smaller,but the effect ofsoilNo-tillalwaysfelt(compared tocontrol).

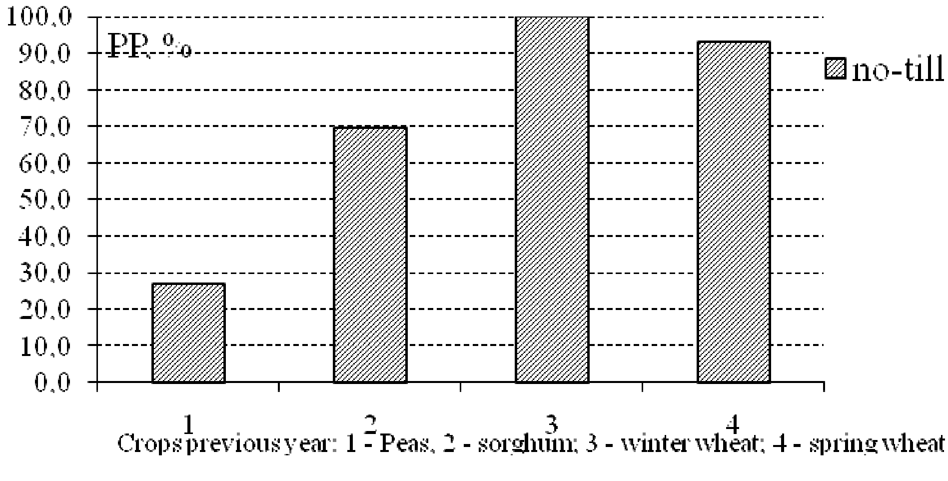

Fig. 2.Influence ofNo-tillon theprojective covergroundplant residues

On the background of this phenomenon the second component of quantitative assessment of the No-till technology undeflationefficiency, namely, lumpy, does not play a particularly prominent role (Fig. 3). This technology has not significantly changed the parameters of soil structure wind resistance. Only in areas where the predecessor of a winter wheat, lumpy surface layer of chernozem southern on the variant with No-till there was a very high - about 80 %, which, according to the existing grouping [8], inherent in most windproof soils. In all other cases,lumpy ranges from 50 to 70%, which indicates the average wind resistance of soils [8].

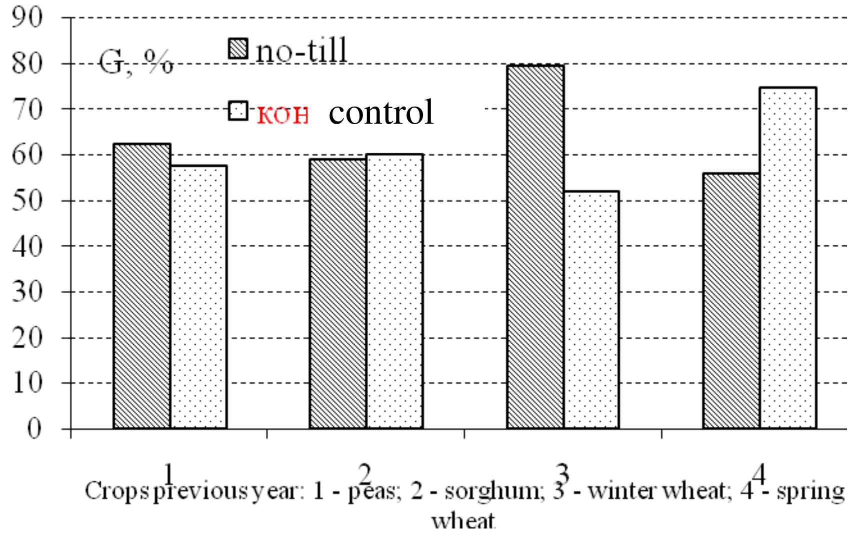

Fig. 3. The effect of No-till on lumpyof soil (G) in spring

In our previous investigations [9,10], it was shown that lumpy (and therefore wind resistance) of soil in spring is largely depends not so much on their properties (size distribution, content of humus, carbonates, etc), but also on meteorological conditions in winter. Given in these papers, the results show that for the autumn-winter period is often produced some of the destruction of soil structure and a significant decrease lumpiness it was under the influence of meteorological factors. Winter unstable, characterized by a large number of thaws, lead to repeated transition temperature of the soil at 0°C, and thus to the destruction of windstable soil structure.

As for wintersof 2011-2013 years, then, according to the meteostation Askaniya Nova, held during the first took place 50 zero-crossing, and for the second - 54. While, according to our investigations [9, 10], soil dispersion starts after 25-30 cycles «freezing - thawing" of the soil surface layer. That is, in both cases the destruction of windstable soil structure should be quite noticeable. Indeed, researches have shown that in variants with traditional cultivation in all cultures settings lumpiness significantly reduced. In particular, during the winter of 2011-2012, lumpy soil in the field where grown peas, decreased more than twice (from 91 to 44%), under sorghum – from 85 to 51%, and under winter wheat from 64 to 52%. During the winter of 2012-2013 soil lumpy where grown peas, decreased from 82 to 71%, sorghum - from 93 to 69 %, spring wheat – from 93 to 74 %.

At the same time, the variant of No-till technology situation is more complicated. Observations showed that lumpy spring compared with autumn definitions, in some cases, if diminished, it is not much, and sometimes even increased. The relationship between the content of lumps more than 1 mm in the spring and and autumn fall of each of the variants of the experiment shows in Fig. 4. Circled the field of points on this graph show the case when significant transformation of windstable soil structureduring winter does not occurs. That is, in this case, or multiple cyclic process of "freezing - thawing " of the soil surface layer does not lead to the destruction of aggregates, or, more likely, the number of cycles for soil, covered with a layer of plant residues is significantly reduced.

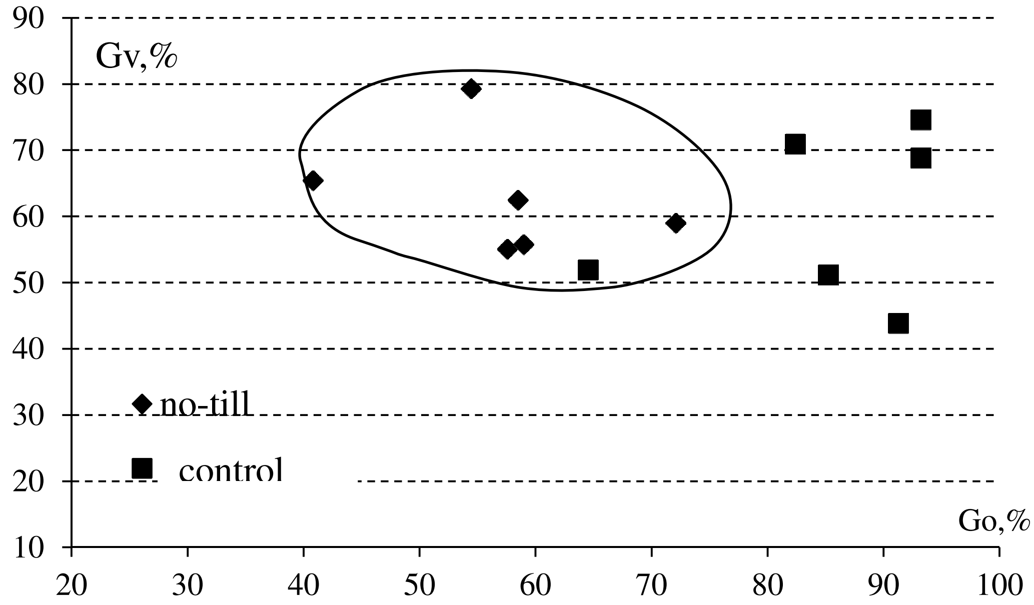

Fig.4. The effect of No-till on the soil lumpiness transformation during the winter months

As can be seen in this area includes all variants of the experiment with No-till, as well as control option predecessor " winter wheat ", which by surface cultivation - a heavy disc harrow disking at 12-14 cm – still a lot of plant residues (Fig. 2). So it is clear that the layer of plant residues on the soil surface is the main reason for suspending the destruction of windstable lumps chernozem southern during winter. Therefore soil properties No-till technology can be seen not only in the context of significant surface protection layer of plant residues and soil protection from spray during winter thaws.

The conclusions. As a result of the research was quantified undeflation effectiveness of No-till technology for chernozem southern. The potential soil losses in the event of the application of this technology are reduced (in most cases) in a several times. The main reason is the substantial increase in the application of No-till covering the soil surface of plant residuesin deflation –dangerous period (February- April). It was also noted stabilizing influence of No-till technology on soil dispersion process, which is observed by a large number of "freeze- thawing" cycles of the soil surface layer under the conditions of continuous winter thaws .

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